Issued: January 24, 2008

Southwest Climate Outlook

The University of Arizona.

Source: Michael O'Neill, Superintendent Agricultural Science Center at Farmington

Photo Description: Snow near the Agricultural Science Center at the University of New Mexico in Farmington, New Mexico on January 10.

Would you like to have your favorite photograph featured on the cover of the *Southwest Climate Outlook*? For consideration send a photo representing Southwest climate and a detailed caption to: knelson7@email.arizona.edu

In this issue...

CLIMAS

Arizona Cooperative Extension — The University of Arizona • College of Agriculture and Life Sciences

Office of the State Climatologist

NM State University

January Climate Summary

Drought – Drought conditions have remained unchanged or improved slightly across Arizona and New Mexico due to precipitation in late November and December. These early winter storms missed much of eastern New Mexico, leaving abnormally dry conditions to persist there. The precipitation across Arizona has improved short-term drought status, but most of the state is experiencing some type of drought.

Temperature – Temperatures have been below average for the past thirty days across Arizona and New Mexico. Most locations observed temperatures 3 to 6 degrees F below average for the period.

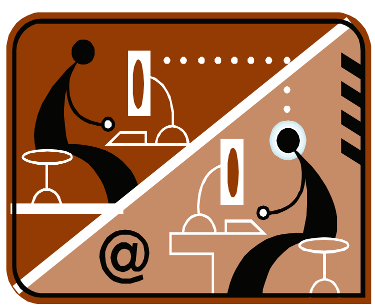
Precipitation – Much of Arizona and New Mexico observed below-average precipitation over the past thirty days. Only northern portions of both states saw average to above-average precipitation due to storms crossing the region in early January.

ENSO – A moderate La Niña is still underway in the Pacific Ocean and is expected to persist through the spring. Forecasts point to a mature La Niña event that is impacting circulation patterns across the Pacific Ocean.

Climate Forecasts – Seasonal climate forecasts continue to indicate that above-average temperatures and below-average precipitation are in store for the Southwest through the spring.

The Bottom Line – Cool and wet conditions in December brought accumulating snow and some short-term drought relief to much of Arizona and New Mexico—a pleasant surprise given the moderate La Niña event underway. The current event is expected to persist and bring below-average precipitation to much of the Southwest through the spring. The current short-term precipitation deficits could continue if typical La Niña impacts emerge as expected over the next several months.

Winter 2008 AZ Climate Web-Briefing



The University of Arizona Cooperative Extension and CLIMAS will host an online climate briefing packed with information for extension faculty, natural resource managers, and interested citizens on Friday, January 25, at 10:00 a.m. MST. The presentation will include an overview of recent conditions and drought status, the latest La Niña status, and an update on winter and spring precipitation and temperature forecasts, followed by a question and answer period. The meeting will be hosted online using the free Breeze web communication software, which integrates voice, chat, and video communications in online meetings and presentations. The Cooperative Extension and CLIMAS hope to see you online!

For more information on how to participate in the meeting visit http://cals.arizona.edu/climate/ws/010208.htm....

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This work is published by the Climate Assessment for the Southwest (CLIMAS) project and the University of Arizona Cooperative Extension; and is funded by CLIMAS, Institute for the Study of Planet Earth, and the Technology and Research Initiative Fund of the University of Arizona Water Sustainability Program through the SAHRA NSF Science and Technology Center at the University of Arizona.

Forecast Verification: Past, Present, and Future

BY JULIE MALMBER, WESTERN WATER ASSESSMENT

Forecasts are issued by meteorologists, climatologists, and hydrologists to predict future weather, climate, and streamflows for a wide variety of purposes including saving lives, reducing damage to property and crops, or even so people can decide what to wear in the morning. Forecast verification is how the quality, skill, and value of a forecast is assessed. The process of forecast verification compares the forecast against a corresponding observation of what actually occurred or an estimate of what occurred. This article discusses some of the many different forecast verification methods, the concept of forecast value to users, and offers some suggestions for forecast users when considering any forecast.

Overview of Forecasts

The three types of forecasts discussed here are weather, climate, and streamflow forecasts. Weather forecasts predict the weather that will occur during a short time frame from six hours to two weeks into the future. Climate forecasts, also called outlooks, predict the average weather conditions for a season or period from several months to years in advance. Climate forecasts do not predict the weather for a certain day, but predict the average weather over several days or months. Examples of climate forecasts from the NOAA Climate Prediction Center (CPC) are on pages 14–15. Streamflow forecasts predict water supply conditions, including streamflow at a point or volume for a period, based upon variables like precipitation and snowmelt. Streamflow forecasts can be daily or seasonal time scales. An example of a streamflow forecast map is on page 17.

History of Forecast Verification

In order to create better forecasts, scientists monitor the forecasts for accuracy and compare different forecasting techniques to see which is better and why (IVMW, 2007). Weather forecasting based upon interpreting weather maps began in the 1850s in the United States, but serious efforts in forecast verification began in the 1880s. In 1884, Sergeant John Finley of the U.S. Army Signal Corps began forecasting tornado occurrences for 18 regions east of the Rocky Mountains. His forecasts were made twice a day and would be either "Tornado" or "No Tornado". This is an example of a dichotomous forecast, where there are only two possible choices. He reported a 95.6–98.6 percent accuracy for the first three months. Ironically, other scientists pointed out that he could have had 98.2 percent accuracy if he forecasted "No Tornado" for all the regions and all the time periods. A 10-year debate started after Finley's publication, referred to as "The Finley Affair." This debate made forecasters realize the need for valid verification methods in order to improve forecasts, and led to the development of verification methods and practices (Murphy, 1996).

Types of Verification

In order for a forecast to be verified, it must be compared with observed conditions. Observational data such as rain gauges, thermometers, stream gauges, satellite data, radar data, eyewitnesses, etc. are used as "truth." In many cases, however, it can be difficult to know the exact "truth" due to instrument error, sampling error, or observation errors. Accurate observations and observation systems, then, are critical to forecast verification.

Forecasters and forecast users have many different ways to verify forecasts and assess quality. Two of the traditional ways are looking at the accuracy and the skill of the forecast. Accuracy is the degree to which the forecast corresponds to what actually happened and depends on both the forecast itself and the accuracy of the measurement or observation. As

mentioned above, observation data can be a limitation in all verification measures, not just accuracy. In addition, the person verifying the forecast uses expert judgment to decide what makes a forecast accurate. For example, a forecast for a high temperature of 75 degrees Farenheit might be considered inaccurate either when the observed high temperature was 76 degrees F or when the high temperature was 85 degrees F.

The second common forecast verification measure is skill. Skill is the accuracy of a forecast over a reference forecast. The reference forecast might be random chance, persistence forecasts, climatology, or even another forecast. A random chance forecast would be like flipping a coin to decide whether or not to forecast precipitation. Persistence forecast is forecasting the same conditions that are happening at the time of the forecast. For example, if it is currently snowing, a persistence forecast is for snow to continue. A forecast of climatology is forecasting the average conditions for the forecast period. A "skillful" forecast must show improvement over a reference forecast.

Other measures of forecast quality besides accuracy and skill include bias,

continued on page 4

Forecast Verification, continued

resolution, and sharpness. Bias measures if forecasts on average are too high or too low relative to the truth. Resolution measures the ability of a series of forecasts to discriminate between distinct types of events, even if the forecast itself is wrong. Sharpness indicates if the forecasts can predict extreme values. Sharpness is important because forecasters can sometimes achieve high skill scores by predicting average conditions but in some cases the occurrence of extreme events may be more important to users. In general, focusing on just one measure of forecast quality may be misleading. For example, in the case of Findley's forecasts, their apparent high accuracy obscured the fact their skill was less than a constant forecast of no tornado.

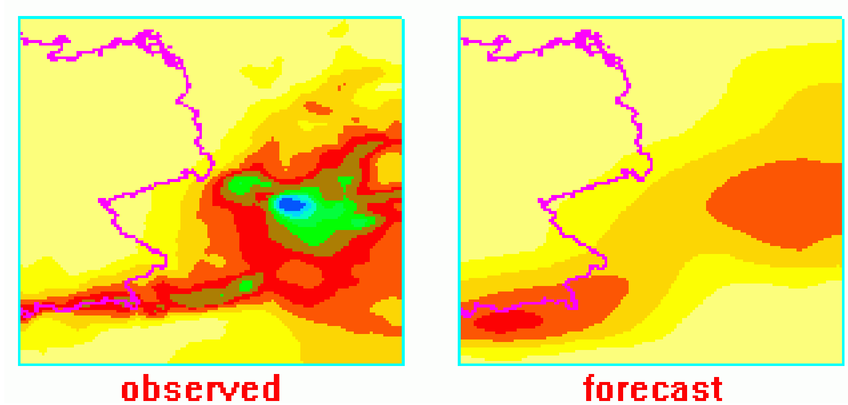


Figure 1a. Observed data versus forecast data (IVMW 2007).

		Observation		
		Yes	**No**	**Total**
Forecast	**Yes**	hits	false alarms	forecast yes
	No	misses	correct negatives	forecast no
	Total	observed yes	observed no	Total

Figure 1b. A contingency table shows what types of errors are being made. A perfect forecasting system would only produce hits and correct negatives.

Methods of Forecast Verification

Forecast verification methods are chosen depending on the type of verification (accuracy or skill) and the type of forecast (dichotomous, continuous, probabilistic, etc.). Examples of verification methods range from simply "eyeballing" the forecast compared to observations, to statistically advanced methods.

Eyeballing a forecast is as simple as it sounds and can be use for a variety of forecasts. A forecaster simply looks at the forecast and the observations side by side to see how well they match up (Figure 1a). "Eyeballing" verification is very subjective and can lead to different outcomes depending on the judgment of the individual forecasters looking at the data.

A contingency table is typically used to verify dichotomous forecasts, like the tornado example above, over a period of time. The table shows the "yes" and "no" forecasts and observations (Figure 1b). To find the accuracy of the forecasts, one must sum "hits" and "correct negatives" and divide by the "Total." This will give a number between 0 and 1; the closer to 1, the more accurate the forecast. This type of score can be very misleading in rare events when forecasting "No" will lead to a high "correct negatives" category such as the occurrence of tornados as in the Findley Affair. Numbers in the contingency table can be combined in many other ways than just accuracy. For example, the False Alarm Ratio is the number of events that were forecasted to occur but did not.

One can numerically verify or calculate the error between the forecast and the observed values with the help of graphical representations. Graphical displays, such as scatter or box-and-whisker plots, are used to verify forecasts of continuous variables such as maximum temperature over a period of days. Scatter plots show the observed amount plotted against the forecast amount. An accurate forecast in this case would lie along the diagonal of the scatter plot.

Box-and-whisker plots can show the distribution of the observed values relative to the forecasted values, which can provide a measure of the resolution of the forecast. In a well-resolved forecast, the box plot of the forecast would appear to have the same spread as the observed values.

Skill scores can be calculated for almost all types of forecasts, but they are most often used for categorical and probabilistic forecasts, like the seasonal climate outlooks issued by NOAA's Climate Prediction Center (CPC) (see pages 14 and 15). All skill scores measure the fraction of correct forecasts to total forecasts after correcting for the number of correct forecasts a reference forecast – generally persistence, climatology or random chance – would obtain. Three types of skill scores are the Heidke skill score, the Brier skill score, and the Ranked Probability skill score. A score between negative infinity to 1 is calculated, with 1 being a perfect score. If forecasts are consistently better than the reference forecast, the score will be closer to 1, a score of 0 indicates no improvement over the reference forecast, and a negative score indicates the forecast performs worse than the reference

continued on page 5

Forecast Verification, continued

forecast. Note that a perversely high negative score may actually provide considerable value if the forecast can be 'inverted'. For this reason, substantial negative skill scores are rarely seen. When comparing skill scores for different forecasts, it is important to use the same method for all forecasts. For example, if you want to compare the CPC seasonal forecast to WWA climatologist Klaus Wolter's experimental seasonal guidance (http://www.cdc.noaa.gov/people/klaus.wolter/SWcasts/index.html), make sure you are looking at either the Heidke or Brier skill score for both.

Forecast Value and Forecast Users

Another important attribute of forecasts is value. A forecast might be highly accurate, skillful, unbiased, sharp and well resolved, and still not be very useful. A valuable forecast best helps a decision maker. For example, a forecast of clear skies over a desert is probably not very helpful. On the other hand, if a forecast helps a decision maker to gain some benefit, the forecast is considered valuable. Accurately forecasting a drought will help water managers to better prepare for low water supply. Forecasting the April 1 snowpack as early as possible would help improve the annual water management operations. In essence, useful forecasts need a wide variety of attributes including accuracy, skill, and value.

NOAA is creating ways to educate decision makers and create better consumers of forecasts. Making forecast verification measures available and explaining the techniques to users will increase the value of forecasts. For example, the Forecast Evaluation Tool and the new verification tools on the NOAA National Weather Service Western Water Supply Application Suite both make verification tools readily available to users (see pink box at right). Users will be able to decide which forecasts they want to use for what purpose, and will know the weaknesses, strengths, or biases of particular forecasts. For example, a certain forecast might tend to predict wetter conditions in the spring.

Verifying a forecast should ultimately lead to improvement in the forecasting techniques and an increase in value to the users.

Overall, forecasters are starting to understand that they need to think about who is using their forecasts and the value of the forecast to the users, not just the skill score or the accuracy of a forecast. While accuracy is very important, it is not the only element of a good forecast. Whether a forecast is for weather, climate, or streamflows, a user should know what information the forecast provides, how the forecast is verified, and limitations of the forecasts and verification methods. If users are educated about forecasts and forecast verification, they will ultimately be better consumers of those forecasts.

References

Murphy, A.H. 1996. *The Finley Affair: A Signal Even in the History of Forecast Verification*. Weather and Forecasting. 11(1): 3-20.

Third International Verification Methods Workshop (IVMW). 2007. Reading, UK. http://www.bom.gov.au/bmrc/wefor/staff/eee/verif/verif_web_page.html

This article originally appeared in the the Intermountain West Climate Summary (http://wwa.colorado.edu/products/forecasts_and_outlooks/intermountain_west_climate_summary/). It is reprinted here with their permission.

WWA is co-sponsoring a workshop on Forecast Verification with NOAA's Colorado Basin River Forecast Center and NRCS on February 19 in Denver., Colorado The workshop will provide forecast users with the tools to evaluate the overall quality of the forecast. It will emphasize water supply forecasts in the Western United States but the concepts will be applicable to climate forecasts as well. Please contact Christina Alvord for more information: christina.alvord@noaa.gov.

Forecast Verification Websites

Two online tools help make forecast verification techniques accessible and understandable to users: the Forecast Evaluation Tool (FET) for NOAA/CPC seasonal climate outlooks and the NOAA National Weather Service (NWS) Western Water Supply Application Suite for their water supply forecasts.

Forecast Evaluation Tool

FET is an online application to look at the successes of CPC seasonal climate forecasts by climate division, season, and lead time of the forecast. Holly Hartmann, a scientist working for CLIMAS, found that forecast users were hesitant to make decisions based upon forecasts without knowing the track record of forecasts. She then initiated FET. In order to use FET, register for free at http://fet.hwr.arizona.edu/ForecastEvaluationTool/. A tutorial is available at the web page. For more information about FET, see the January 2006 Intermountain West Climate Summary.

NWS Western Water Supply Application Suite

The NOAA/NWS Western Water Supply Application Suite launched in January 2008. This brand new tool allows users to select a state, river, and station and then visualize data and also calculate error statistics and skill statistics. The web page is available at: http://www.nwrfc.noaa.gov/westernwater/. To access the verification section, when you get to the web page, first select "Change Application" and then select the "Verification" tab. At this point, the regional data can be entered. More information is also available by selecting the "About Western Water Supply" tab and then the "Verification" tab.

Temperature (through 1/16/08)

Source: High Plains Regional Climate Center

Since the start of the water year, temperatures generally are averaging between 50 and 65 degrees Fahrenheit in the lower deserts to between 35 and 50 degrees F in the higher elevations of Arizona and most of New Mexico (Figures 1a–b). Temperatures are 1–3 degrees F above average across most of both states, about 1 degree cooler than a month ago. So far, the higher temperatures have not adversely affected the region's snowfall, which has been near to above average. A series of cold low pressure systems sweeping through the Southwest during the past thirty days has lowered temperatures throughout the region (Figures 1c–d). Temperatures in Arizona have been 0–4 degrees F below average, while New Mexico has had similar below-average temperatures in the western two-thirds of the state and slightly higher-than-average temperatures in the east. The alignment of the low pressure troughs has steered cold storm systems southward along the Pacific coast, or down the Sierra Nevada Mountains, then northeastward across Arizona and into Colorado. This pattern causes the storms to bypass most of New Mexico, leaving the central and eastern parts of that state relatively warm and dry. The Climate Prediction Center continues to forecast warmer-than-average conditions through spring (see Figures 9a–d).

Notes:

The water year begins on October 1 and ends on September 30 of the following year. Water year is more commonly used in association with precipitation; water year temperature can be used to measure the temperatures associated with the hydrological activity during the water year.

Average refers to the arithmetic mean of annual data from 1971–2000. Departure from average temperature is calculated by subtracting current data from the average. The result can be positive or negative.

The continuous color maps (Figures 1a, 1b, 1c) are derived by taking measurements at individual meteorological stations and mathematically interpolating (estimating) values between known data points. The dots in Figure 1d show data values for individual stations. Interpolation procedures can cause aberrant values in data-sparse regions.

These are experimental products from the High Plains Regional Climate Center.

On the Web:

For these and other temperature maps, visit:
http://www.hprcc.unl.edu/products/current.html

For information on temperature and precipitation trends, visit:
http://www.cpc.ncep.noaa.gov/trndtext.shtml

Figure 1a. Water year '07–'08 (through January 16, 2008) average temperature.

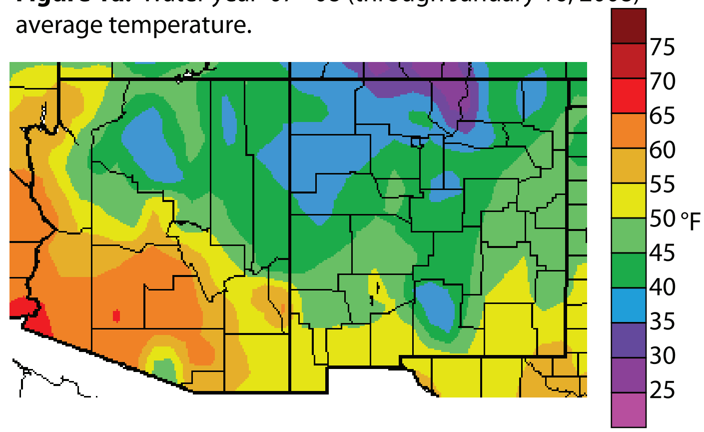


Figure 1b. Water year '07–'08 (through January 16, 2008) departure from average temperature.

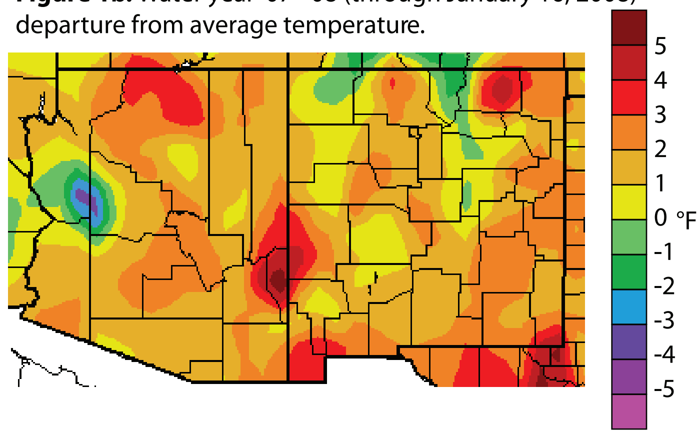


Figure 1c. Previous 30 days (December 18, 2007–January 16, 2008) departure from average temperature (interpolated).

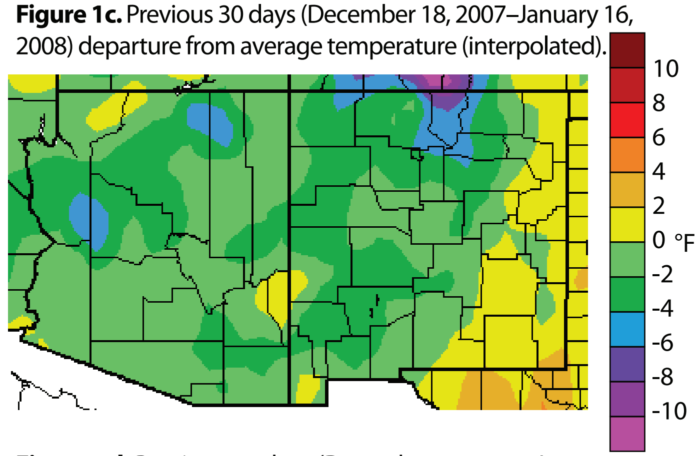
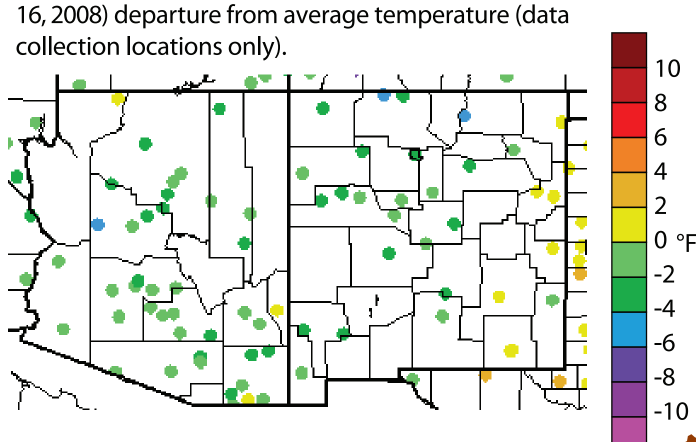


Figure 1d. Previous 30 days (December 18, 2007–January 16, 2008) departure from average temperature (data collection locations only).



Precipitation (through 1/16/08)

Source: High Plains Regional Climate Center

For the water year, Arizona is faring better than New Mexico, with most mountain regions at or above 100 percent of average precipitation (Figures 2a–b). Eastern New Mexico has received less than 50 percent of average precipitation and the central part of the state has had between 50 and 90 percent of average. The wet weather in November saturated the ground, so the spring runoff should be high, provided that average or above-average precipitation continues and there is no early snowmelt. The past thirty days have brought above-average precipitation to northern Arizona and parts of northern New Mexico (Figures 2c–d). Precipitation has been 100–200 percent of average on most of the Colorado Plateau as a result of two major storm systems, one just before Christmas and the other at the end of the first week of January. The circulation pattern has alternated between a high pressure ridge over the West and a low pressure trough. The ridge is a dominant feature of a La Niña circulation, but the regularity of the troughs is unusual, though welcome. As a result, snowpack is above average both in the Pacific Northwest and Rockies as well as in the Sierra Nevada and Arizona-New Mexico mountain ranges. Southern New Mexico and Arizona generally have remained dry, with 75 percent or less of average precipitation.

Notes:

The water year begins on October 1 and ends on September 30 of the following year. As of October 1, 2007, we are in the 2008 water year. The water year is a more hydrologically sound measure of climate and hydrological activity than is the standard calendar year.

Average refers to the arithmetic mean of annual data from 1971–2000. Percent of average precipitation is calculated by taking the ratio of current to average precipitation and multiplying by 100.

The continuous color maps (Figures 2a, 2c) are derived by taking measurements at individual meteorological stations and mathematically interpolating (estimating) values between known data points. Interpolation procedures can cause aberrant values in data-sparse regions.

The dots in Figures 2b and 2d show data values for individual meteorological stations.

On the Web:

For these and other precipitation maps, visit:
http://www.hprcc.unl.edu/products/current.html

For National Climatic Data Center monthly precipitation and drought reports for Arizona, New Mexico, and the Southwest region, visit: http://lwf.ncdc.noaa.gov/oa/climate/research/2003/perspectives.html#monthly

Figure 2a. Water year '07–'08 (through January 16, 2007) percent of average precipitation (interpolated).

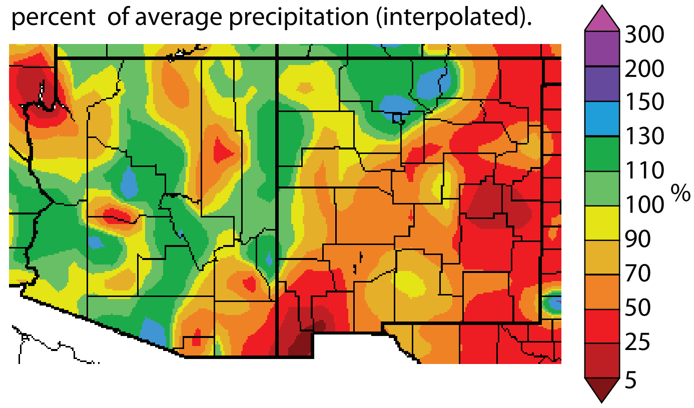


Figure 2b. Water year '07–'08 (through January 16, 2007) percent of average precipitation (data collection locations only).

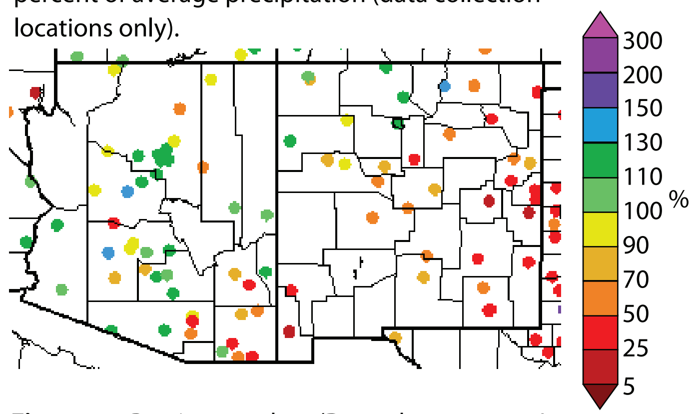


Figure 2c. Previous 30 days (December 18, 2007–January 16, 2008) percent of average precipitation (interpolated).

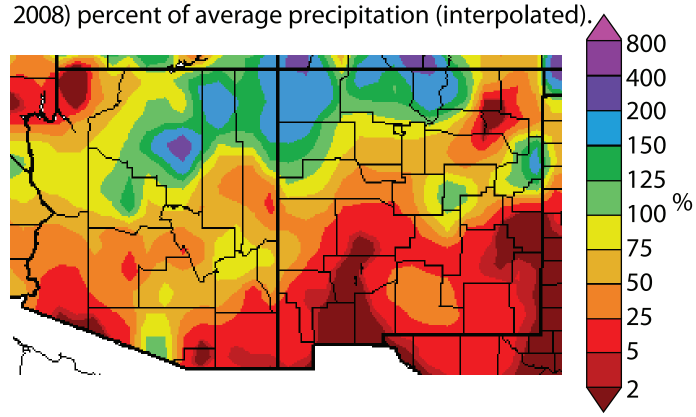
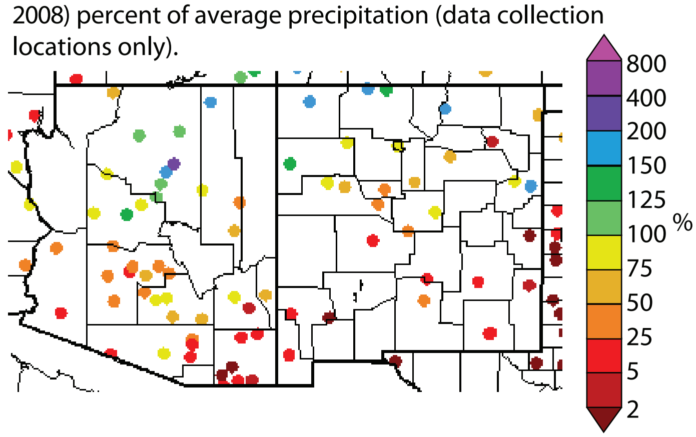


Figure 2d. Previous 30 days (December 18, 2007–January 16, 2008) percent of average precipitation (data collection locations only).



U.S. Drought Monitor

(released 1/17/08)

Sources: U.S. Department of Agriculture, National Drought Mitigation Center, National Oceanic and Atmospheric Administration

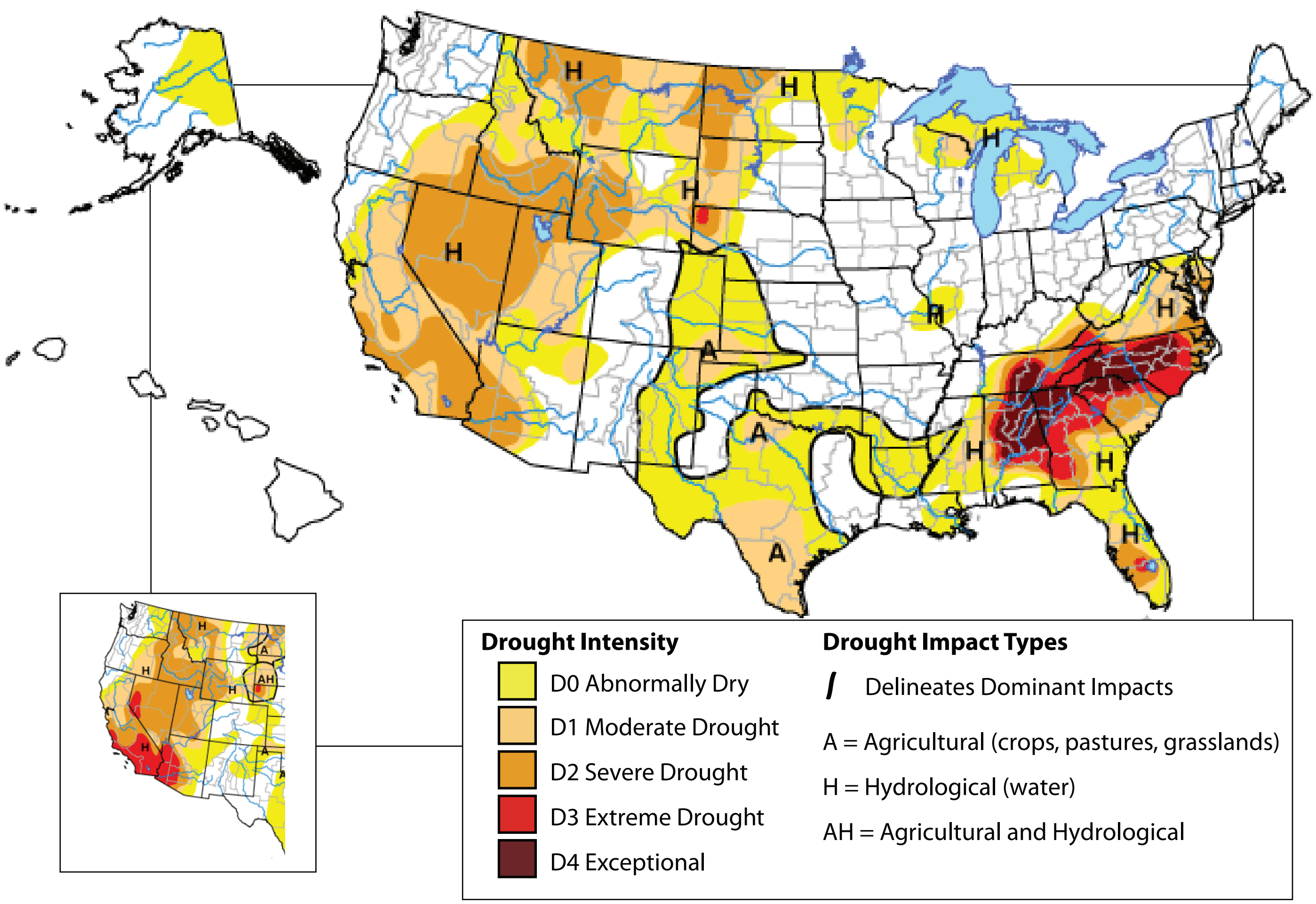
Drought conditions have improved across much of Arizona, while much of New Mexico has remained drought free over the past two months (Figure 3). A cool and wet December in Arizona helped reduce the spatial extent of areas under some type of drought from 93 percent in late November to 70 percent with the latest National Drought Monitor update. Even with the reduction in intensity and coverage, the pattern of drought across Arizona persists. The southwestern portions of the state are still experiencing the worst conditions, with severe drought continuing. Moderate to abnormally dry conditions are present across the northwest and north-central regions, while the remainder of the state is drought free. The wet and cool December also helped more than half of New Mexico remain drought free. Abnormally dry conditions continue through the eastern third of the state due to below-average precipitation even during December, when the rest of the region saw above-average precipitation. Slightly more than 40 percent of the state is experiencing abnormally dry conditions.

Notes:

The U.S. Drought Monitor is released weekly (every Thursday) and represents data collected through the previous Tuesday. The inset (lower left) shows the western United States from the previous month's map.

The U.S. Drought Monitor maps are based on expert assessment of variables including (but not limited to) the Palmer Drought Severity Index, soil moisture, streamflow, precipitation, and measures of vegetation stress, as well as reports of drought impacts. It is a joint effort of the several agencies; the author of this monitor is Rich Tinker, CPC/NOAA.

Figure 3. Drought Monitor released January 17, 2008 (full size) and November 15, 2007 (inset, lower left).



On the Web:

The best way to monitor drought trends is to pay a weekly visit to the U.S. Drought Monitor website: http://www.drought.unl.edu/dm/monitor.html

Arizona Drought Status
(through 11/30/07)

Source: Arizona Department of Water Resources

Short-term drought conditions across Arizona worsened slightly, while long-term conditions remained largely unchanged. The December update of the Arizona Drought Monitor Report shows most of the short-term changes occurred across the Upper Colorado River watershed in the northern part of the state (Figure 4a). Abnormally dry conditions in October and early November caught up with the drought status calculations for this watershed, raising the November abnormally dry status to moderate in December. The only short-term status improvement from November to December occurred in the San Simon River Watershed, where the status decreased from severe to moderate drought. Abnormally dry to moderate short-term drought conditions persist across the rest of the state, with the Agua Fria and Bill Williams River watersheds seeing the worse drought conditions. Long-term conditions remained steady with most watersheds observing moderate to severe drought conditions based on long-term precipitation deficits and below-average streamflows (Figure 4b).

Precipitation in late November and throughout December has helped put a dent in the drought but hasn't lifted Arizona completely out of trouble, according to meteorologists at the National Weather Service (NWS) in Phoenix. Steve Sipple, NWS meteorologist, said Phoenix recorded almost twice its monthly average with a storm that passed through the state on November 30 (Associated Press, December 28). Forecasters said the precipitation helps short-term drought conditions.

Figure 4a. Arizona short-term drought status for December 2007.

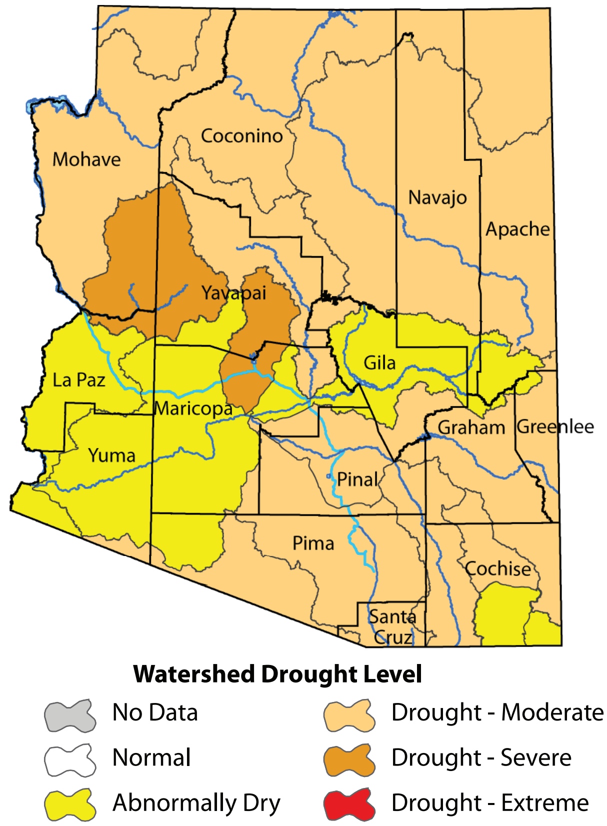
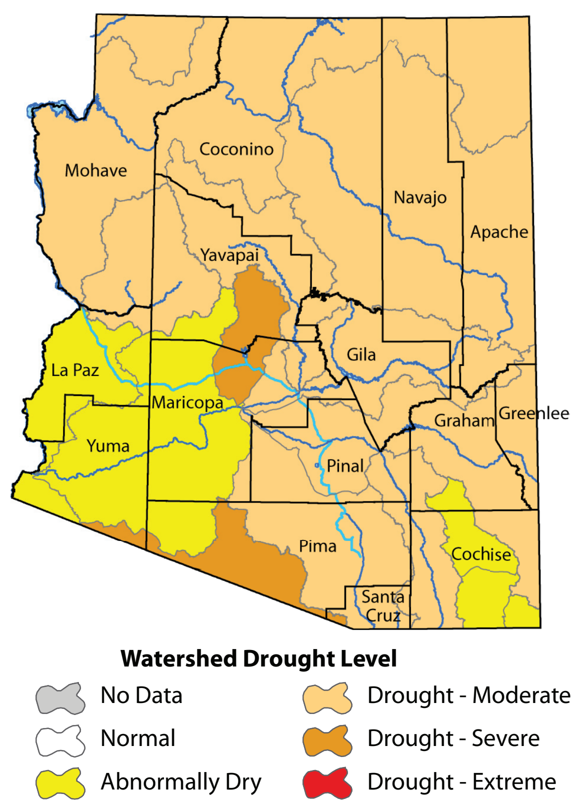


Figure 4b. Arizona long-term drought status for December 2007.



Notes:

The Arizona drought status maps are produced monthly by the Arizona Drought Preparedness Plan Monitoring Technical Committee. The maps are based on expert assessment of variables including, but not limited to, precipitation, drought indices, reservoir levels, and streamflow.

Figure 4a shows short-term or meteorological drought conditions. Meteorological drought is defined usually on the basis of the degree of dryness (in comparison to some "normal" or average amount) over a relatively short duration (e.g., months). Figure 4b refers to long-term drought, sometimes known as hydrological drought. Hydrological drought is associated with the effects of relatively long periods of precipitation shortfall (e.g., many months to years) on water supplies (i.e., streamflow, reservoir and lake levels, and groundwater). These maps are delineated by river basins (wavy gray lines) and counties (straight black lines).

On the Web:

For the most current Arizona drought status maps, visit:
http://www.azwater.gov/dwr/drought/DroughtStatus.html

New Mexico Drought Status

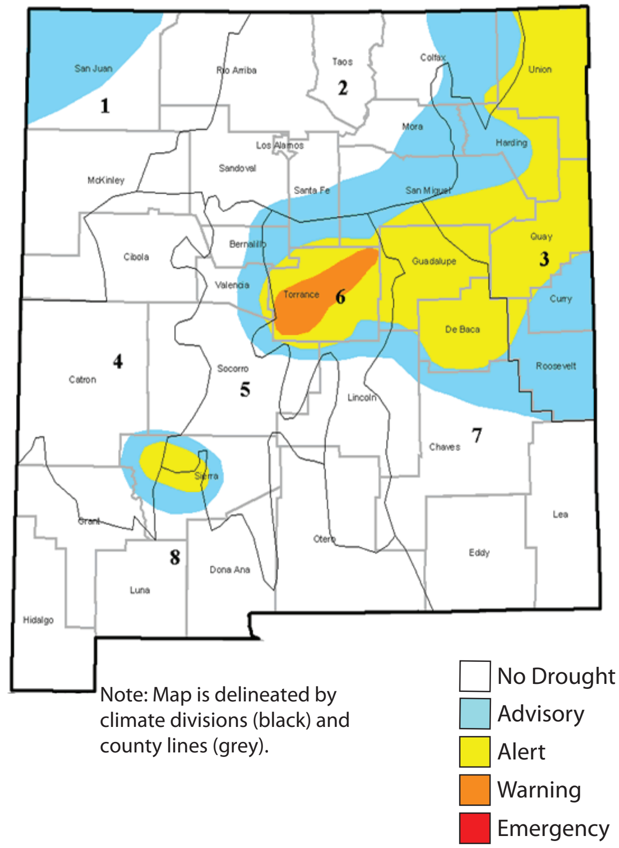
(through 12/31/07)

Source: New Mexico State Drought Monitoring Committee

The December New Mexico Drought Status map shows an improvement in conditions over the northwest and north central parts of the state (Figure 5). The area of alert status in the Four Corners region was downgraded to an advisory status and drought depictions were removed from Los Alamos, northern Sandoval, and northern Santa Fe counties. These changes reflect the abundant precipitation that fell in late November and early December as several storm systems moved through the state and brought significant moisture to counties in the west, northwest, and north central areas. That precipitation was not enough to outweigh persistent dry conditions in the area extending from Torrance County east to the Texas border. The warning status area over Torrance County expanded slightly, while the swath of advisory and alert conditions remained relatively unchanged. Much of southern New Mexico remained drought free, with the exception of a small area over Sierra County.

For agricultural impacts in New Mexico, the drought status report noted that adequate soil moisture conditions existed across 45 percent of the state in mid-December. The driest conditions were in the northeast, where only 18 percent of the area had adequate conditions. The "Adequate" indicates that soil is moist and that "seed germination and/or crop growth and development would be normal or unhindered," according to the U.S. Department of Agriculture.

Figure 5. Short-term drought map based on meteorological conditions for December 2007.



Notes:

The New Mexico drought status map is produced monthly by the New Mexico State Drought Monitoring Committee. When near-normal conditions exist, they are updated quarterly. The map is based on expert assessment of variables including, but not limited to, precipitation, drought indices, reservoir levels, and streamflow.

Figure 5 shows short-term or *meteorological* drought conditions. Meteorological drought is defined usually on the basis of the degree of dryness (in comparison to some "normal" or average amount) over a relatively short duration (e.g., months).

On the Web:

For the most current meteorological drought status map, visit:
http://www.srh.noaa.gov/abq/feature/droughtinfo.htm

For the most current hydrological drought status map, visit:
http://www.nm.nrcs.usda.gov/snow/drought/drought.html

Arizona Reservoir Levels

(through 12/31/07)

Source: National Water and Climate Center

During the last month, storage increased in most Arizona reservoirs (Figure 6). Storage in Lakes Powell and Mead is expected to decline until the spring 2008 snowmelt runoff season, when current forecasts anticipate slightly above-average inflow to Lake Powell (see Figure 12). Storage in the Salt and Verde River reservoirs increased by more than 240,000 acre-feet during the last month, following a series of storms that began in late November.

Quagga mussels were discovered at multiple sites in Lake Pleasant, northwest of Phoenix (*Arizona Republic*, January 1). These tiny invasive mollusks can multiply quickly and clog water intakes and pipes. Repairs can cost millions of dollars. The mussels pose no known human health risk, but they can disrupt ecosystems by robbing other aquatic life of oxygen. Currently, there is no safe method of eradicating quagga mussels. Arizona officials are encouraging boaters to to inspect vessels that come in contact with the lake water.

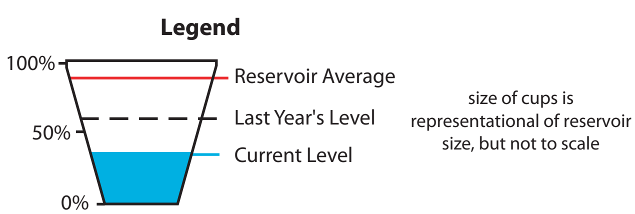
Notes:

The map gives a representation of current storage levels for reservoirs in Arizona. Reservoir locations are numbered within the blue circles on the map, corresponding to the reservoirs listed in the table. The cup next to each reservoir shows the current storage level (blue fill) as a percent of total capacity. Note that while the size of each cup varies with the size of the reservoir, these are representational and not to scale. Each cup also represents last year's storage level (dotted line) and the 1971–2000 reservoir average (red line).

The table details more exactly the current capacity level (listed as a percent of maximum storage). Current and maximum storage levels are given in thousands of acre-feet for each reservoir. One acre-foot is the volume of water sufficient to cover an acre of land to a depth of 1 foot (approximately 325,851 gallons). On average, 1 acre-foot of water is enough to meet the demands of 4 people for a year. The last column of the table list an increase or decrease in storage since last month. A line indicates no change.

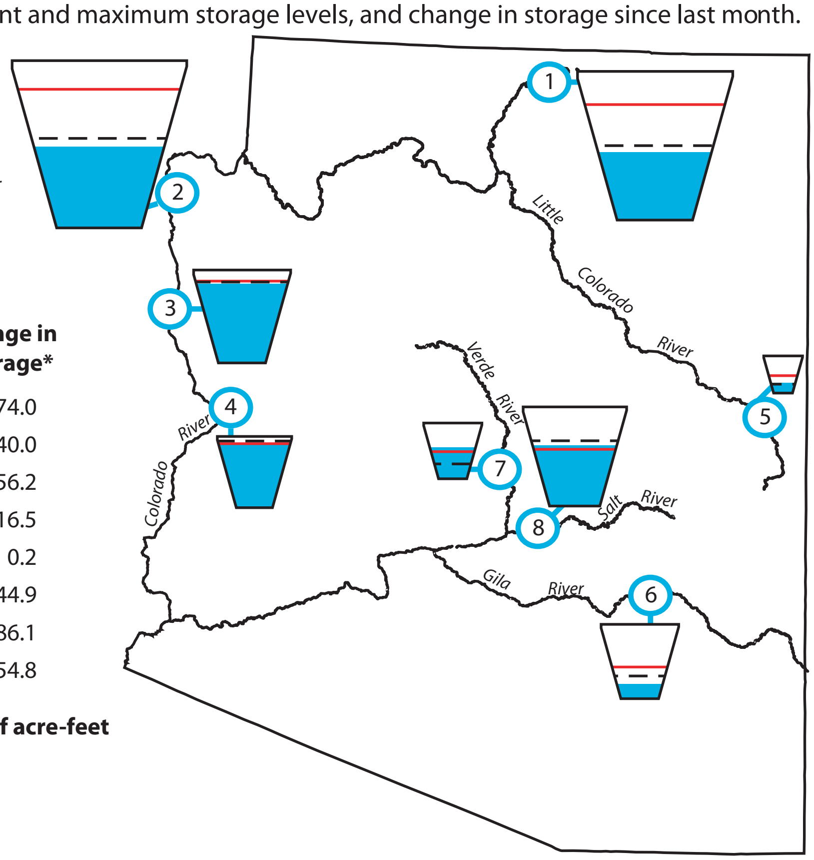
These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resource Conservation Service (NRCS). For additional information, contact Larry Martinez, NRCS, Larry.Martinez@az.usda.gov.

Figure 6. Arizona reservoir levels for December 2007 as a percent of capacity. The map also depicts the average level and last year's storage for each reservoir. The table also lists current and maximum storage levels, and change in storage since last month.



Reservoir Name	Capacity Level	Current Storage*	Max Storage*	Change in Storage*
1. Lake Powell	46%	11,246.0	24,322.0	-374.0
2. Lake Mead	49%	12,860.0	26,159.0	340.0
3. Lake Mohave	86%	1,565.0	1,810.0	56.2
4. Lake Havasu	90%	556.9	619.0	-16.5
5. Lyman Reservoir	28%	8.3	30.0	0.2
6. San Carlos	20%	177.8	875.0	44.9
7. Verde River System	56%	161.7	287.4	86.1
8. Salt River System	61%	1,227.7	2,025.8	154.8

*** thousands of acre-feet**



On the Web:

Portions of the information provided in this figure can be accessed at the NRCS website: http://www.wcc.nrcs.usda.gov/wsf/reservoir/resv_rpt.html

New Mexico Reservoir Levels

(through 12/31/07)

Source: National Water and Climate Center

New Mexico statewide reservoir storage fell slightly since last month, with the greatest declines at Navajo, Brantley, and Conchas reservoirs (Figure 7).

The city of Farmington, New Mexico, received a small grant from San Juan County to eradicate invasive "water hog" riparian plants, like salt cedar and Russian olive (*Farmington Daily Times*, January 7). The large-scale removal will involve cutting trees and using a special kind of mulcher and herbicide treatments on the stumps. The invasive vegetation will be replaced by native New Mexico olive and cottonwood.

Santa Fe, which pays $1.5 million to lease approximately 2,000 acre-feet of water from the Jicarilla Apache Nation, can expect costs to increase due to inflation and increasing water rights costs (*Santa Fe New Mexican*, January 11). Most of the water Santa Fe receives from the tribe is released into the Rio Grande to offset drinking water the city pumps from its well field.

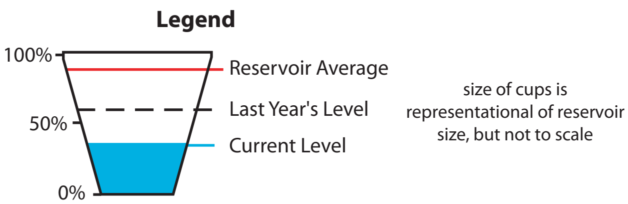
Notes:

The map gives a representation of current storage levels for reservoirs in New Mexico. Reservoir locations are numbered within the blue circles on the map, corresponding to the reservoirs listed in the table. The cup next to each reservoir shows the current storage level (blue fill) as a percent of total capacity. Note that while the size of each cup varies with the size of the reservoir, these are representational and not to scale. Each cup also represents last year's storage level (dotted line) and the 1971–2000 reservoir average (red line).

The table details more exactly the current capacity level (listed as a percent of maximum storage). Current and maximum storage levels are given in thousands of acre-feet for each reservoir. One acre-foot is the volume of water sufficient to cover an acre of land to a depth of 1 foot (approximately 325,851 gallons). On average, 1 acre-foot of water is enough to meet the demands of 4 people for a year. The last column of the table list an increase or decrease in storage since last month. A line indicates no change.

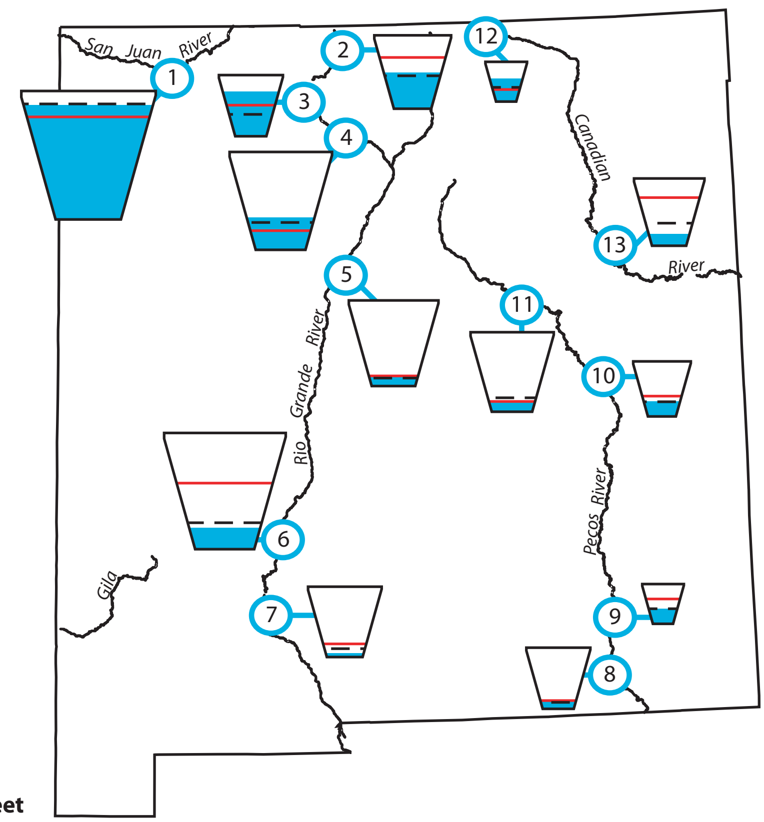
These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resource Conservation Service (NRCS). For additional information, contact Larry Martinez, NRCS, Larry.Martinez@az.usda.gov.

Figure 7. New Mexico reservoir levels for December 2007 as a percent of capacity. The map also depicts the average level and last year's storage for each reservoir. The table also lists current and maximum storage levels, and change in storage since last month.



Reservoir Name	Capacity Level	Current Storage*	Max Storage*	Change in Storage*
1. Navajo	87%	1,479.0	1,696.0	-2.5
2. Heron	49%	195.2	400.0	-27.7
3. El Vado	73%	142.2	195.0	22.8
4. Abiquiu	33%	180.5	554.5	-1.3
5. Cochiti	10%	50.1	491.0	-0.3
6. Elephant Butte	19%	408.8	2,195.0	56.8
7. Caballo	7%	24.0	332.0	1.8
8. Brantley	13%	18.5	147.5	12.8
9. Lake Avalon	38%	1.5	4.0	1.1
10. Sumner	27%	27.8	102.0	10.3
11. Santa Rosa	11%	50.3	438.3	0.5
12. Costilla	58%	9.3	16.0	0.6
13. Conchas	16%	39.5	254.2	-0.4

*** thousands of acre-feet**



On the Web:

Portions of the information provided in this figure can be accessed at the NRCS website: http://www.wcc.nrcs.usda.gov/wsf/reservoir/resv_rpt.html

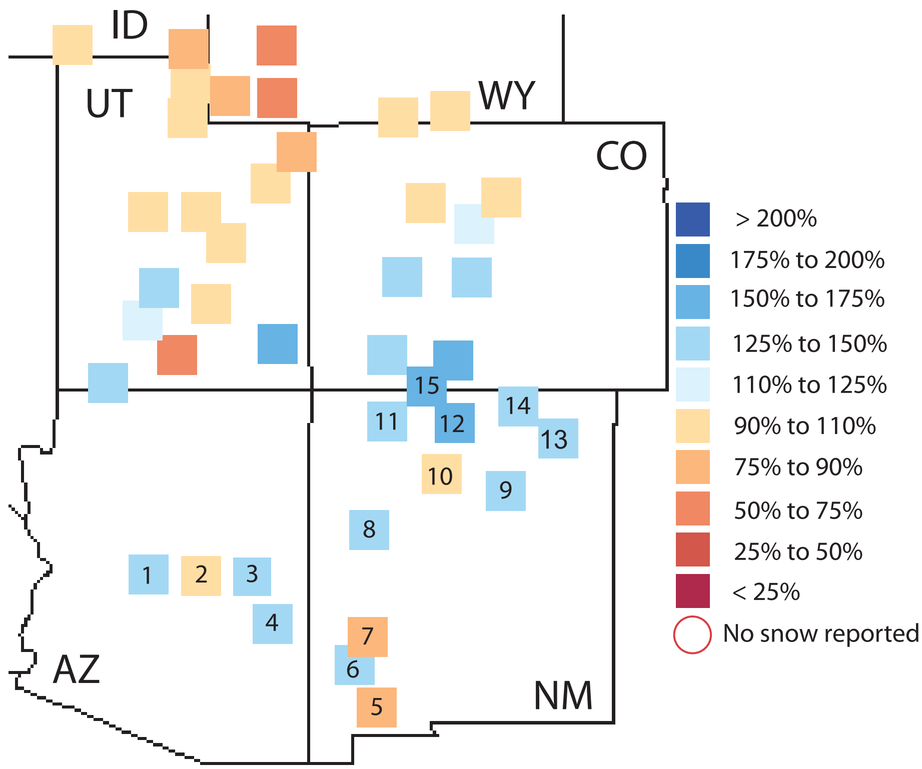
Southwest Snowpack

(updated 1/17/08)

Sources: National Water and Climate Center, Western Regional Climate Center

Despite the La Niña-driven below-average precipitation forecasts for November and December, snowpack observations in most locations across the Southwest are near to above average (Figure 8). SNOTEL stations in Arizona and northern New Mexico are reporting snow water equivalent (SWE) values ranging from 90 to 175 percent of average for mid-January. Locations in the southern Gila Mountains in New Mexico have slightly less snowpack, with 75 to 90 percent of average. Several cold storm systems that crossed the region in late November and through December brought accumulating shots of snowfall that developed the current snowpack. Average to below-average temperatures through December into early January have helped maintain the snowpack levels. Additional snowpack is necessary over the next several months to keep on track with average seasonal accumulations; nevertheless, these current above-average levels should help support streamflows into the spring.

Figure 8. Average snow water content (SWC) in percent of average for available monitoring sites as of January 17, 2008.



Arizona Basins
1 Verde River Basin
2 Central Mogollon Rim
3 Little Colorado - Southern Headwaters
4 Salt River Basin

New Mexico Basins
5 Mimbres River Basin
6 San Francisco River Basin
7 Gila River Basin
8 Zuni/Bluewater River Basin
9 Pecos River
10 Jemez River Basin
11 San Miguel, Dolores, Animas, and San Juan River Basins
12 Rio Chama River Basin
13 Cimarron River Basin
14 Sangre de Cristo Mountain Range Basin
15 San Juan River Headwaters

On the Web:

For color maps of SNOTEL basin snow water content, visit: http://www.wrcc.dri.edu/snotelanom/basinswe.html

For a numeric version of the map, visit: http://www.wrcc.dri.edu/snotelanom/basinswen.html

For a list of river basin snow water content and precipitation, visit: http://www.wrcc.dri.edu/snotelanom/snotelbasin

Notes:

Snowpack telemetry (SNOTEL) sites are automated stations that measure snowpack depth, temperature, precipitation, soil moisture content, and soil saturation. A parameter called snow water content (SWC) or snow water equivalent (SWE) is calculated from this information. SWC refers to the depth of water that would result by melting the snowpack at the SNOTEL site and is important in estimating runoff and streamflow. It depends mainly on the density of the snow. Given two snow samples of the same depth, heavy, wet snow will yield a greater SWC than light, powdery snow.

Figure 8 shows the SWC for selected river basins, based on SNOTEL sites in or near the basins, compared to the 1971–2000 average values. The number of SNOTEL sites varies by basin. Basins with more than one site are represented as an average of the sites. Individual sites do not always report data due to lack of snow or instrument error.

Temperature Outlook

(February–July 2008)

Source: NOAA Climate Prediction Center (CPC)

Forecasts for the Southwest are predicting increased chances of above-average temperatures through July 2008 (Figs 9a–d). The chance of above-average temperatures in the region exceeds 50 percent relative to average or below-average temperatures in each month. These forecasts for above-average temperatures encompass all of Arizona and New Mexico for the February–April 2008 period, but shift with highest probabilities centered on Arizona by the May–July 2008 period. These forecasts are based on past temperature patterns associated with La Niña events as well as the expectation that long-term trends in above-average temperatures will persist through the spring.

Notes:

These outlooks predict the likelihood (chance) of above-average, average, and below-average temperature, but not the magnitude of such variation. The numbers on the maps do not refer to degrees of temperature.

The NOAA-CPC outlooks are a 3-category forecast. As a starting point, the 1971–2000 climate record is divided into 3 categories, each with a 33.3 percent chance of occurring (i.e., equal chances, EC). The forecast indicates the likelihood of one of the extremes—above-average (A) or below-average (B)—with a corresponding adjustment to the other extreme category; the "average" category is preserved at 33.3 likelihood, unless the forecast is very strong.

Thus, using the NOAA-CPC temperature outlook, areas with light brown shading display a 33.3–39.9 percent chance of above-average, a 33.3 percent chance of average, and a 26.7–33.3 percent chance of below-average temperature. A shade darker brown indicates a 40.0–50.0 percent chance of above-average, a 33.3 percent chance of average, and a 16.7–26.6 percent chance of below-average temperature, and so on.

Equal Chances (EC) indicates areas where the reliability (i.e., 'skill') of the forecast is poor; areas labeled EC suggest an equal likelihood of above-average, average, and below-average conditions, as a "default option" when forecast skill is poor.

Figure 9a. Long-lead national temperature forecast for February–April 2008.

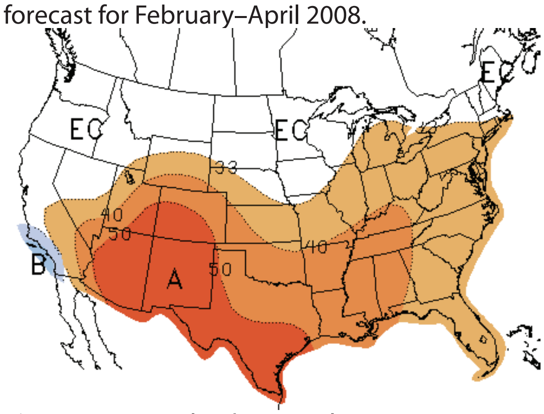
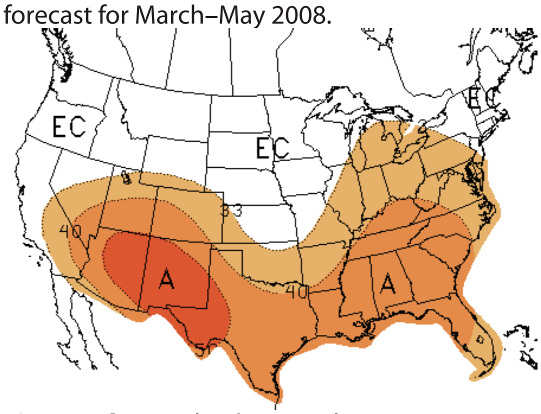


Figure9b. Long-lead national temperature forecast for March–May 2008.



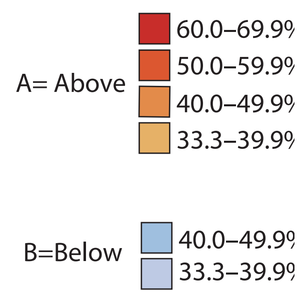


Figure 9c. Long-lead national temperature forecast for April–June 2008.

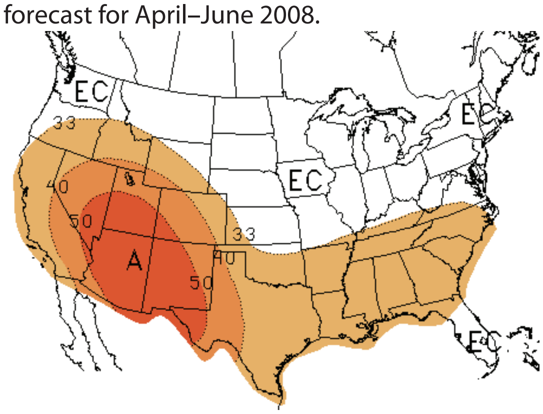
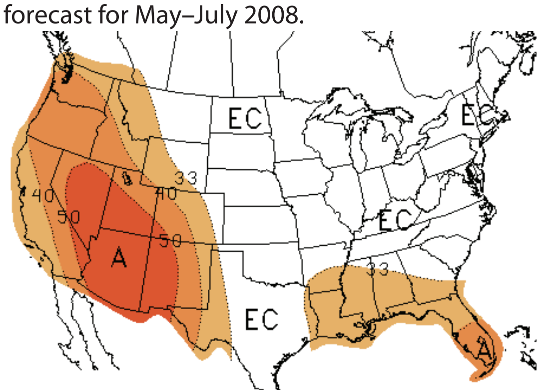


Figure 9d. Long-lead national temperature forecast for May–July 2008.



EC= Equal chances. No forecasted anomalies.

On the Web:

For more information on CPC forecasts, visit:
http://www.cpc.ncep.noaa.gov/products/predictions/multi_season/13_seasonal_outlooks/color/churchill.html
(note that this website has many graphics and may load slowly on your computer)

For IRI forecasts, visit:
http://iri.columbia.edu/climate/forecast/net_asmt/

Precipitation Outlook

(February–July 2008)

Source: NOAA Climate Prediction Center (CPC)

Seasonal forecasts call for increased chances of below-average precipitation through the early spring for all of Arizona and New Mexico. A greater than 33 percent chance of below-average precipitation (relative to average or above-average precipitation occurring) is forecasted across the Southwest for the February–April and March–May periods (Figures 10 a–b). The chances for below-average precipitation are even higher (greater than 40 percent) across most of Arizona for the same period. These forecasts are based on the expectation that the current moderate-strength La Niña event will persist through the spring and bring typical La Niña impacts, like below-average precipitation, to the southwestern U.S. The forecast for below-average precipitation shifts a bit northward by the April–June period, due to decreasing La Niña impacts and increased forecast uncertainty (Figure 10c).

Notes:

These outlooks predict the likelihood (chance) of above-average, average, and below-average precipitation, but not the magnitude of such variation. The numbers on the maps do not refer to inches of precipitation.

The NOAA-CPC outlooks are a 3-category forecast. As a starting point, the 1971–2000 climate record is divided into 3 categories, each with a 33.3 percent chance of occurring (i.e., equal chances, EC). The forecast indicates the likelihood of one of the extremes—above-average (A) or below-average (B)—with a corresponding adjustment to the other extreme category; the "average" category is preserved at 33.3 likelihood, unless the forecast is very strong.

Thus, using the NOAA-CPC precipitation outlook, areas with light green shading display a 33.3–39.9 percent chance of above-average, a 33.3 percent chance of average, and a 26.7–33.3 percent chance of below-average precipitation. A shade darker green indicates a 40.0–50.0 percent chance of above-average, a 33.3 percent chance of average, and a 16.7–26.6 percent chance of below-average precipitation, and so on.

Equal Chances (EC) indicates areas where the reliability (i.e., 'skill') of the forecast is poor; areas labeled EC suggest an equal likelihood of above-average, average, and below-average conditions, as a "default option" when forecast skill is poor.

Figure 10a. Long-lead national precipitation forecast for February–April 2008.

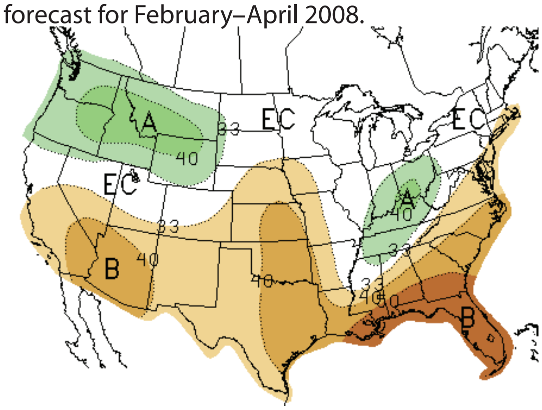


Figure 10b. Long-lead national precipitation forecast for March–May 2008.

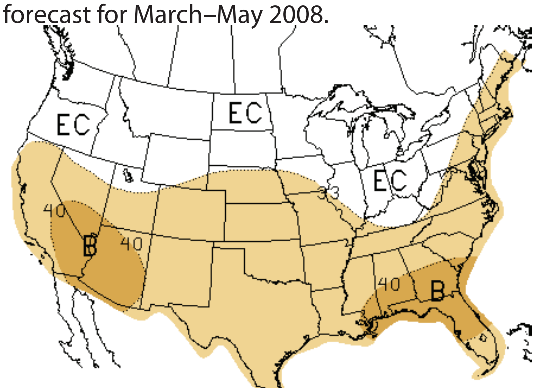


Figure 10c. Long-lead national precipitation forecast for April–June 2008.

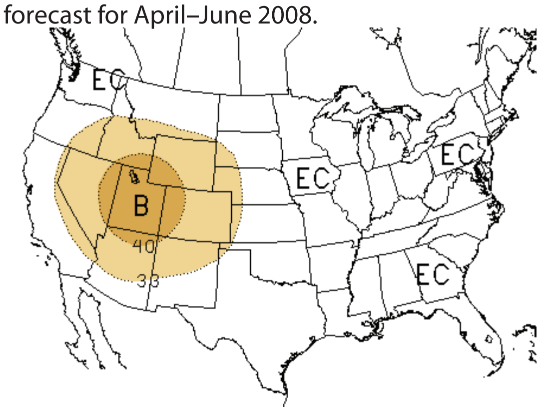
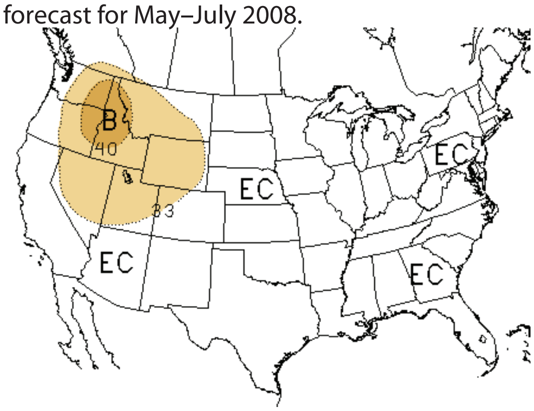


Figure 10d. Long-lead national precipitation forecast for May–July 2008.



A= Above: 40.0–49.9%; 33.3–39.9%

B= Below: 33.3–39.9%; 40.0–49.9%; 50.0–59.9%

EC= Equal chances. No forecasted anomalies.

On the Web:

For more information on CPC forecasts, visit:
http://www.cpc.ncep.noaa.gov/products/predictions/multi_season/13_seasonal_outlooks/color/churchill.html
(note that this website has many graphics and may load slowly on your computer)

For IRI forecasts, visit:
http://iri.columbia.edu/climate/forecast/net_asmt/

Seasonal Drought Outlook
(through April 2008)

Source: NOAA Climate Prediction Center (CPC)

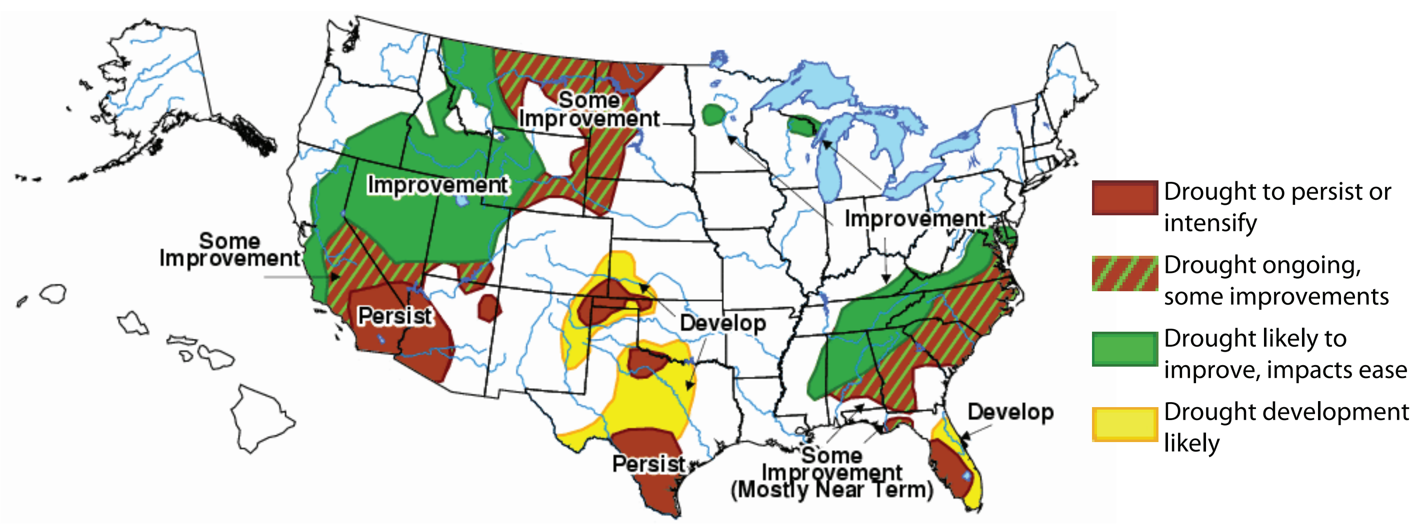
The latest NOAA Seasonal Drought Outlook predicts that drought will develop across eastern New Mexico and persist or intensify in western and northeastern Arizona and in the southern Plains where New Mexico, Colorado, Texas, Oklahoma, and Kansas meet (Figure 11). The forecast is based primarily on the expected persistence of La Niña conditions through spring 2008 (see Figure 14b). La Niña precipitation composites—averages of similar past events that have been adjusted for long-term precipitation trends—and a consolidation of various statistical and dynamical model forecasts from the NOAA CPC favor slightly increased chances of below-average precipitation throughout the Southwest and southern and central Great Plains this winter and spring. Experimental precipitation forecasts (not shown) from the International Research Institute for Climate and Society indicate increased chances of below-average precipitation for most of northern Sonora and Chihuahua in Mexico throughout the late winter and spring.

The Salt River Project (SRP), one of the largest water providers in the state, may pursue legal action against Prescott, Prescott Valley, and Chino Valley over groundwater pumping by these municipalities from the Big Chino sub-basin aquifer (*Prescott Courier*, December 31). The aquifer provides about 80 percent of the baseflow of the Upper Verde River, which in turn provides about 33 percent of SRP's in-state surface water supply. SRP is pressing the municipalities for a binding cooperative mitigation plan before the municipalities begin pumping. SRP is a senior water rights holder on the Verde.

Notes:

The delineated areas in the Seasonal Drought Outlook (Figure 11) are defined subjectively and are based on expert assessment of numerous indicators, including outputs of short- and long-term forecasting models.

Figure 11. Seasonal drought outlook through April 2008 (released January 17, 2008).



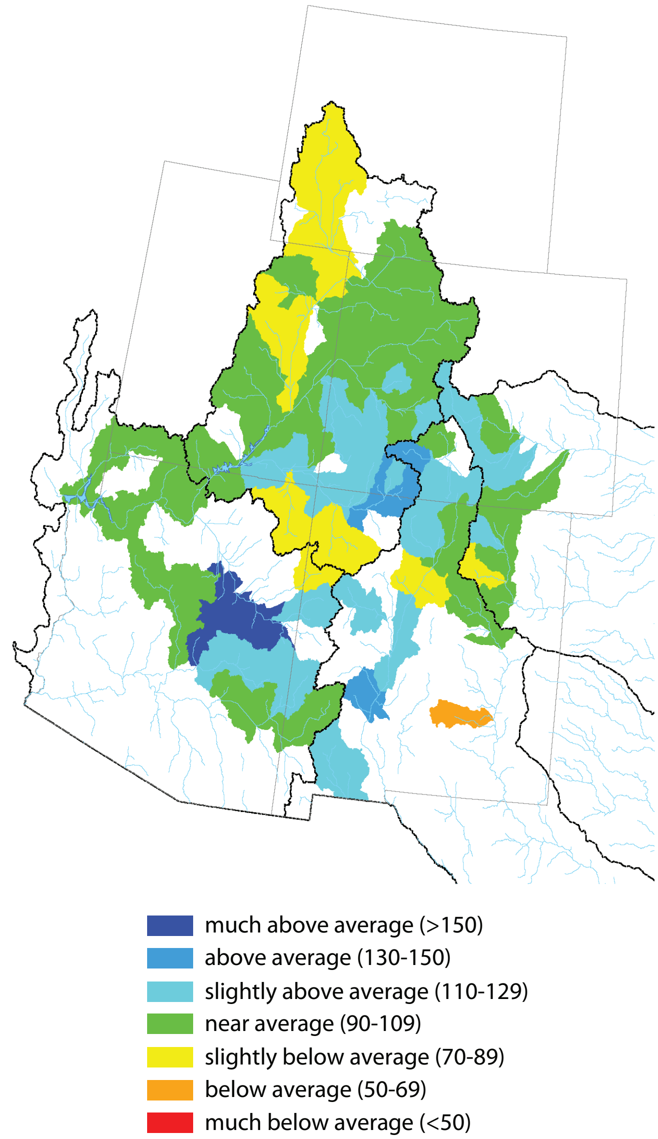
On the Web:
For more information, visit:
http://www.drought.noaa.gov/

Streamflow Forecast
(for spring and summer)
Source: National Water and Climate Center

The first spring-summer 2008 streamflow forecast for the Southwest shows near-average to above-average flows for most basins in Arizona and New Mexico (Figure 12). There is at least a 50 percent chance that inflow to Lake Powell will be 101 percent of the thirty year average for April–July. Predictions for the Salt and Verde river watersheds are well above average, based primarily on outstanding early winter snowpack. Forecasts for streams originating in the Chuska Mountains of northeastern Arizona indicate slightly below-average flows. In the San Francisco and Upper Gila River basins, the predictions are for near-average inflow to the San Carlos Reservoir, with above-average flows along the San Francisco River; mostly below-average flows are forecast for gages along the Gila. In New Mexico, forecasts indicate above-average spring-summer flows for all large basins, with the exception of the Pecos River. In New Mexico, snowpack, a major indicator of future streamflow, is above-average in all basins except the Mimbres and the Rio Hondo.

Arizona hydrologists are responding to the streamflow forecasts with guarded optimism; they note that the state is only mid-way through the snow season, and that in recent years, warm spring temperatures and strong winds have rapidly ablated snowpacks—removed them by melting or evaporation—and reduced previously optimistic streamflow forecasts (*Arizona Republic*, January 14).

Figure 12. Spring and summer streamflow forecast as of January 1, 2008 (percent of average).



Notes:
The forecast information provided in Figure 12 is updated monthly by the National Water and Climate Center, part of the U.S. Department of Agriculture's Natural Resources Conservation Service. Unless otherwise specified, all streamflow forecasts are for streamflow volumes that would occur naturally without any upstream influences, such as reservoirs and diversions. The USDA-NRCS only produces streamflow forecasts for Arizona between January and April, and for New Mexico between January and May.

The NWCC provides a range of forecasts expressed in terms of percent of average streamflow for various statistical exceedance levels. The streamflow forecast presented here is for the 50 percent exceedance level, and is referred to as the most probable streamflow. This means there is at least a 50 percent chance that streamflow will occur at the percent of average shown in Figure 12.

On the Web:
For state river basin streamflow probability charts, visit:
http://www.wcc.nrcs.usda.gov/cgibin/strm_cht.pl

For information on interpreting streamflow forecasts, visit:
http://www.wcc.nrcs.usda.gov/factpub/intrpret.html

For western U.S. water supply outlooks, visit:
http://www.wcc.nrcs.usda.gov/water/quantity/westwide.html

El Niño Status and Forecast

Sources: NOAA Climate Prediction Center (CPC), International Research Institute for Climate and Society (IRI)

The La Niña event that developed this past fall continued to persist through December into early January. The International Research Institute for Climate and Society (IRI) notes that much colder-than-average sea surface temperatures (SSTs) and stronger-than-normal easterly surface winds across the equatorial Pacific Ocean have continued to support moderate to strong La Niña conditions. SSTs up to 2.5 degrees Celsius below average were observed in regions of the Pacific. These temperatures, in concert with strong easterly winds, supported the rapid development and maintenance of La Niña conditions from October through December, according to IRI. Southern Oscillation Index (SOI) values also indicate that atmospheric circulation patterns across the Pacific have started to organize around this current La Niña. SOI values shifted from 0.9 in November to 1.8 in December (Figure 13a).

Forecasts from the NOAA Climate Prediction Center (CPC) and IRI both indicate a strong chance that La Niña conditions will continue to persist through the spring (Figure 13b).

Notes:

Figure 13a shows the standardized three month running average values of the Southern Oscillation Index (SOI) from January 1980 through December 2007. The SOI measures the atmospheric response to SST changes across the Pacific Ocean Basin. The SOI is strongly associated with climate effects in the Southwest. Values greater than 0.5 represent La Niña conditions, which are frequently associated with dry winters and sometimes with wet summers. Values less than -0.5 represent El Niño conditions, which are often associated with wet winters.

Figure 13b shows the International Research Institute for Climate Prediction (IRI) probabilistic El Niño-Southern Oscillation (ENSO) forecast for overlapping three month seasons. The forecast expresses the probabilities (chances) of the occurrence of three ocean conditions in the ENSO-sensitive Niño 3.4 region, as follows: El Niño, defined as the warmest 25 percent of Niño 3.4 sea-surface temperatures (SSTs) during the three month period in question; La Niña conditions, the coolest 25 percent of Niño 3.4 SSTs; and neutral conditions where SSTs fall within the remaining 50 percent of observations. The IRI probabilistic ENSO forecast is a subjective assessment of current model forecasts of Niño 3.4 SSTs that are made monthly. The forecast takes into account the indications of the individual forecast models (including expert knowledge of model skill), an average of the models, and other factors.

On the Web:

For a technical discussion of current El Niño conditions, visit: http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/

For more information about El Niño and to access graphics similar to the figures on this page, visit: http://iri.columbia.edu/climate/ENSO/

Probabilistic forecasts produced by IRI indicate a 96 percent chance that the current La Niña will continue through March and an 88 percent chance through May. The return to neutral conditions is expected to occur sometime this summer. Seasonal precipitation forecasts continue to rely heavily on the La Niña event continuing. Below-average precipitation across the Southwest, typical during La Niña events, is expected over the next several months.

Figure 13a. The standardized values of the Southern Oscillation Index from January 1980–December 2007. La Niña/El Niño occurs when values are greater than 0.5 (blue) or less than -0.5 (red) respectively. Values between these thresholds are relatively neutral (green).

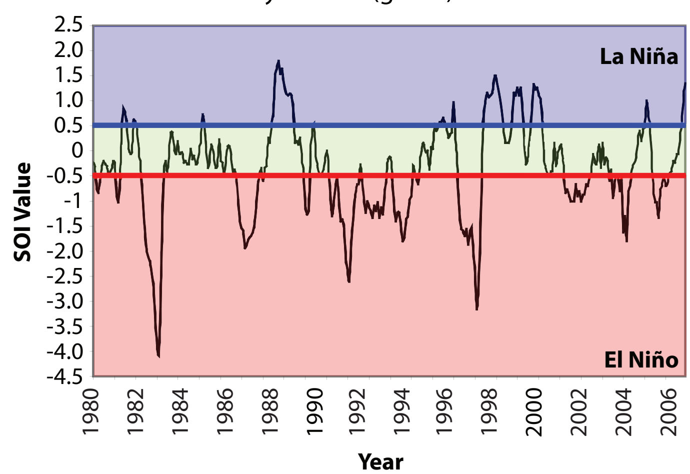
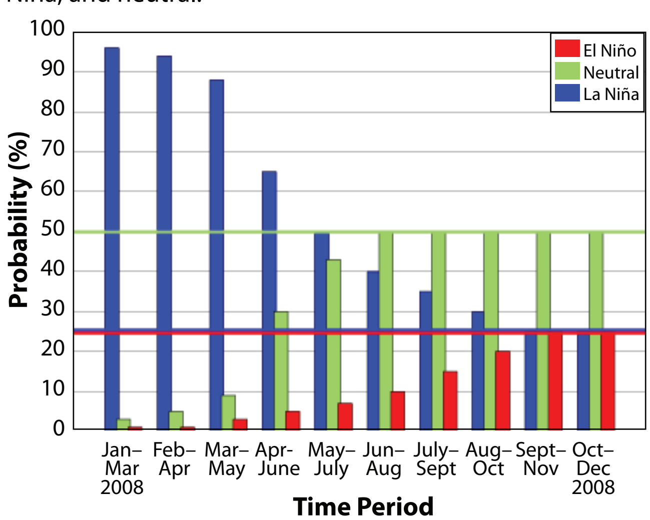


Figure 13b. IRI probabilistic ENSO forecast for El Niño 3.4 monitoring region (released January 17, 2008). Colored lines represent average historical probability of El Niño, La Niña, and neutral.

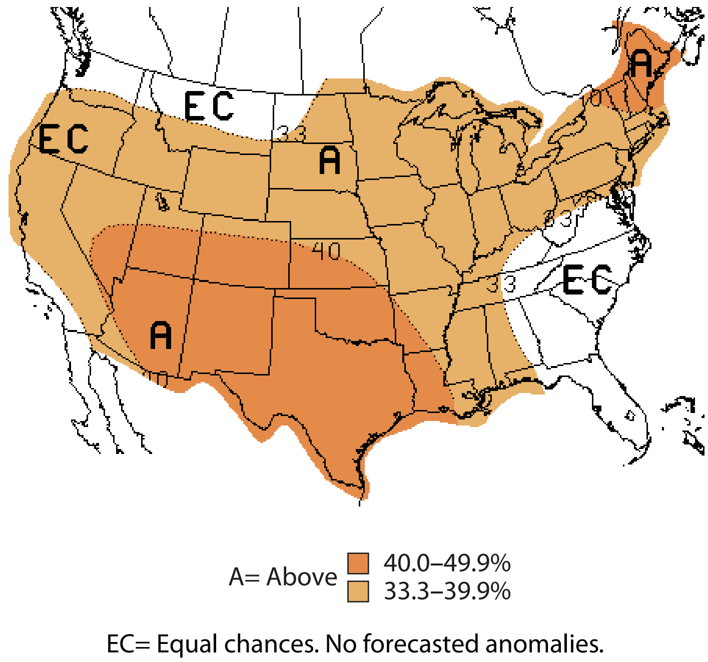


Temperature Verification
(October–December 2007)

Source: NOAA Climate Prediction Center (CPC)

The NOAA-CPC seasonal temperature outlook for October–December 2007 predicted increased chances of above-average temperatures for most of the U.S., including probabilities of above-average precipitation (greater than 40 percent) throughout the Southwest (Figure 14a). These predictions were based on a combination of long-term trends and expected effects associated with a strengthening La Niña episode in the Pacific Ocean. Temperatures were above-average over much of the U.S., due mostly to an exceedingly warm fall, especially in the southern half of the country (Figure 14b). Beginning in late November, a series of storms crossing California into the Southwest cooled December temperatures; thus, forecasts performed less well over large portions of the West. The forecasts did not anticipate well-above average temperatures in the Southeast.

Figure 14a. Long-lead U.S. temperature forecast for October–December 2007 (issued September 2007).



Notes:

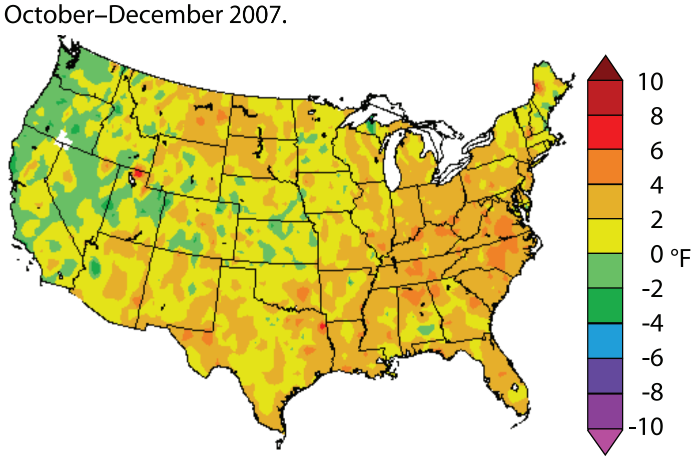
Figure 14a shows the NOAA Climate Prediction Center (CPC) temperature outlook for the months October–December 2007. This forecast was made in September 2007.

The outlook predicts the likelihood (chance) of above-average, average, and below-average temperature, but not the magnitude of such variation. The numbers on the maps do not refer to degrees of temperature.

Using past climate as a guide to average conditions and dividing the past record into 3 categories, there is a 33.3 percent chance of above-average, a 33.3 percent chance of average, and a 33.3 percent chance of below-average temperature. Thus, using the NOAA CPC likelihood forecast, in areas with light brown shading there is a 33.3–39.9 percent chance of above-average, a 33.3 percent chance of average, and a 26.7–33.3 percent chance of below-average precipitation. Equal Chances (EC) indicates areas where reliability (i.e., the skill) of the forecast is poor and no prediction is offered.

Figure 14b shows the observed departure of temperature (degrees F) from the average for the October–December 2007 period. Care should be exercised when comparing the forecast (probability) map with the observed temperature maps. The temperature departures do not represent probability classes as in the forecast maps, so they are not strictly comparable. They do provide us with some idea of how well the forecast performed. In all of the figures on this page, the term average refers to the 1971–2000 average. This practice is standard in the field of climatology.

Figure 14b. Average temperature departure (in degrees F) for October–December 2007.



On the Web:

For more information on CPC forecasts, visit:
http://www.cpc.ncep.noaa.gov/products/predictions/multi_season/13_seasonal_outlooks/color/churchill.html

Precipitation Verification

(October–December 2007)

Source: NOAA Climate Prediction Center (CPC)

The NOAA-CPC seasonal precipitation outlook for October–December 2007 predicted increased probabilities of below-average precipitation in the Southwest and central and southern Great Plains and increased probabilities of above-average precipitation for the Pacific Northwest and Northern Rockies (Figure 15a). The overall spatial pattern of observed precipitation matched the forecasts for the two forecast regions, with a few notable exceptions (Figure 15b). The southern part of the northwestern U.S., where above-average precipitation was forecast and for which the CPC only ventured slight changes in the probabilities, had average to below-average precipitation during the forecast period. Southern California, parts of Arizona, north-central New Mexico, and southwestern Texas received average to above-average precipitation. The forecast was pretty much spot-on through the last week of November, when a warm weather system off Baja California brought copious precipitation to Arizona. In mid-December, a cold storm system that originated in the Gulf of Alaska brought abundant moisture to parts of Arizona and New Mexico.

Figure 15a. Long-lead U.S. precipitation forecast for October–December 2007 (issued September 2007).

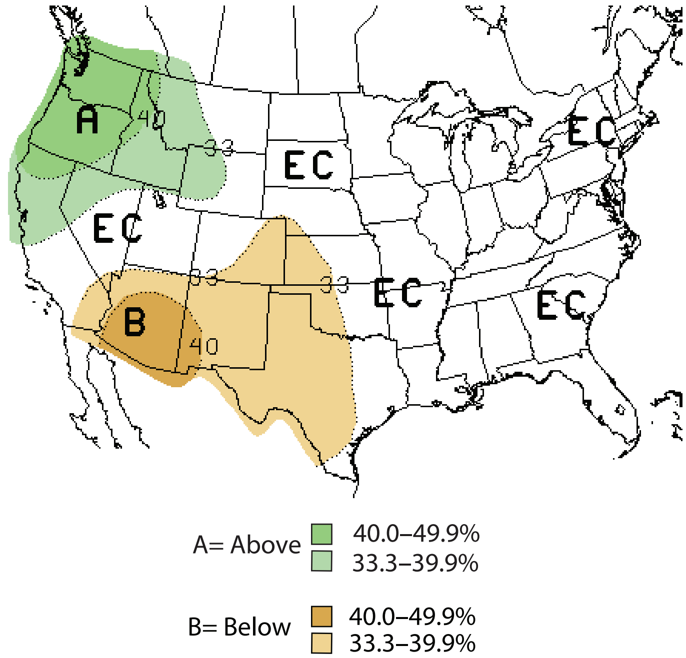
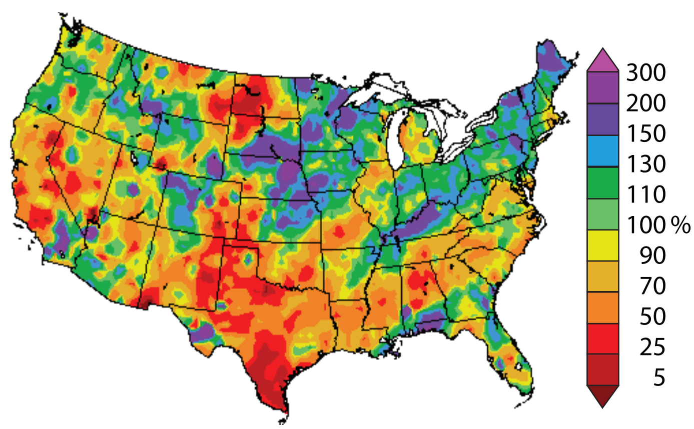


Figure 15b. Percent of average precipitation observed from October–December 2007.



Notes:

Figure 15a shows the NOAA Climate Prediction Center (CPC) precipitation outlook for the months October–December 2007. This forecast was made in September 2007.

The outlook predicts the likelihood (chance) of above-average, average, and below-average precipitation, but not the magnitude of such variation. The numbers on the maps do not refer to inches of precipitation. Using past climate as a guide to average conditions and dividing the past record into 3 categories, there is a 33.3 percent chance of above-average, a 33.3 percent chance of average, and a 33.3 percent chance of below-average precipitation. Thus, using the NOAA CPC likelihood forecast, in areas with light brown shading there is a 33.3–39.9 percent chance of above-average, a 33.3 percent chance of average, and a 26.7–33.3 percent chance of below-average precipitation. Equal Chances (EC) indicates areas where reliability (i.e., the skill) of the forecast is poor and no prediction is offered.

Figure 15b shows the observed percent of average precipitation for October–December 2007. Care should be exercised when comparing the forecast (probability) map with the observed precipitation maps. The observed precipitation amounts do not represent probability classes as in the forecast maps, so they are not strictly comparable, but they do provide us with some idea of how well the forecast performed.

In all of the figures on this page, the term average refers to the 1971–2000 average. This practice is standard in the field of climatology.

On the Web:

For more information on CPC forecasts, visit:
http://www.cpc.ncep.noaa.gov/products/predictions/multi_season/13_seasonal_outlooks/color/churchill.html